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AEROSOL PARTICLE ANALYSIS BY MASS SPECTROMETRY

A new technique for analyzing the chemical composition of single aerosol particles within the diameter range of 0.1 to 5 micrometers on a continuous, real-time basis is currently being developed at the Jet Propulsion Laboratory in collaboration with the University of California at Los Angeles (UCLA). It involves a combination of particle beam generation and mass spectrometric methods. The key enabling technology is the application of a JPL-developed ultrasensitive electro-optical ion detection (EOID) scheme for mass spectrometry.

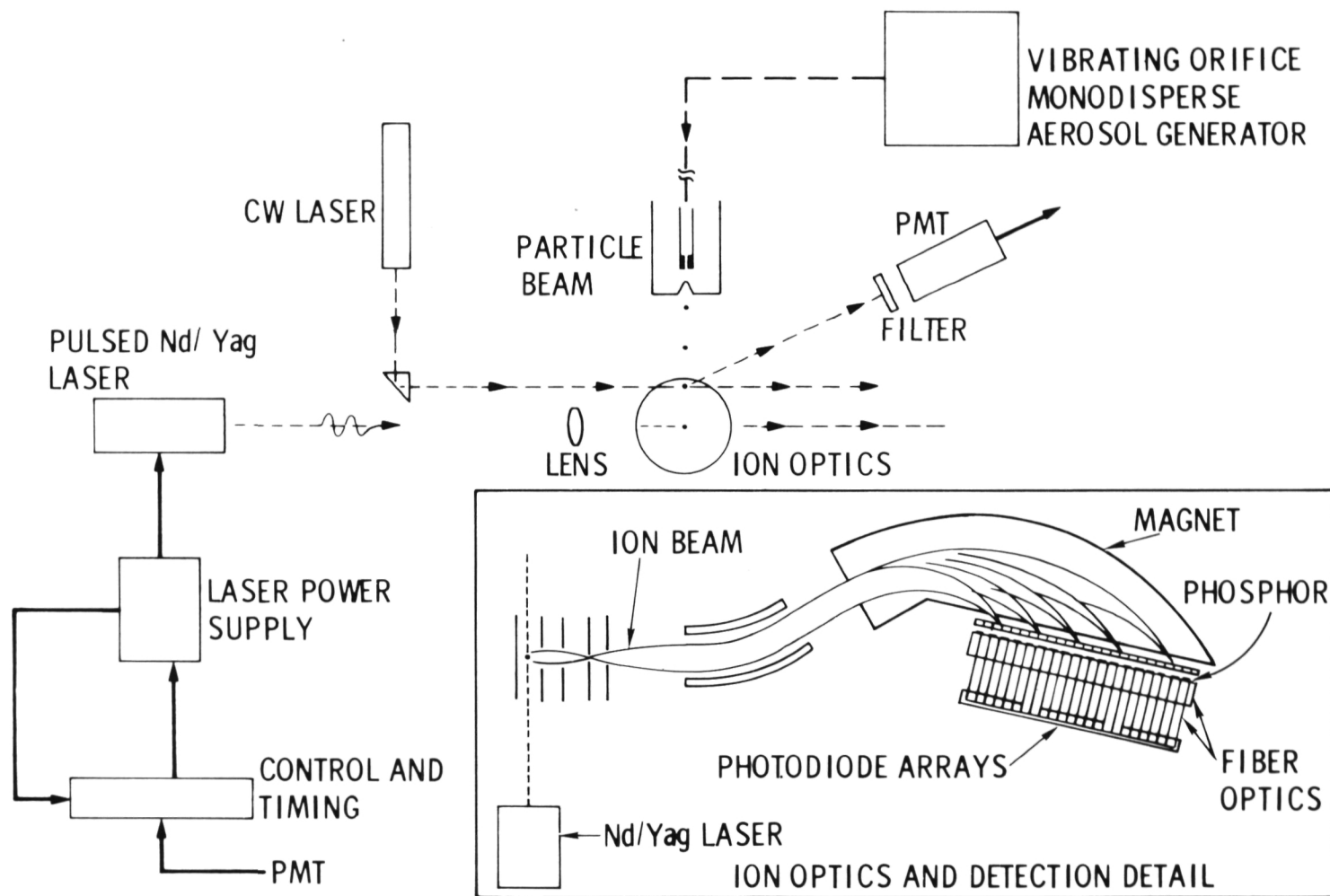
The goals of this research are (1) to prepare the aerosol particles for their efficient introduction into the ion source region of the spectrometer, (2) to develop an optimum method for particle volatilization and ionization, (3) to relate the resultant mass spectra to the chemical composition of the incoming particles, and (4) to apply the technique to the measurements of atmospheric aerosol and biological particles such as bacteria and viruses.

A beam of monodisperse (same size) particles of known chemical composition and flux has been generated. Methods for the volatilization and ionization of these aerosol particles are being studied. A combination of thermal volatilization of individual particles by impaction on a hot rhenium surface with electron bombardment ionization was employed for the chemical analysis. Results were obtained with different inorganic and organic aerosol particles of varying sizes.

One system of practical importance is sulfate/sulfite analysis of particles. Impaction of ammonium sulfate particles on a hot rhenium filament followed by electron bombardment results in fragment ions of SO^+ , SO_2^+ , and SO_3^+ (oxides of sulfur) from the sulfate part of the salt. No signal of SO_3^+ is observed from a sulfite particle. The absence of SO_3^+ ions from sulfite and its pronounced appearance from sulfate furnish a simple method for the identification and differentiation of sulfites and sulfates.

A major effort is being made to develop a soft, general, efficient method of vaporization and ionization. In particular, studies with a high-energy pulsed laser are being made. The controlled, extremely rapid heating provided by a short laser pulse is expected to provide undissociated ions of the parent molecules. This source is being interfaced with an existing focal plane mass spectrometer with EOID, allowing simultaneous measurement of ions within the mass range of 25-500 atomic mass units from single aerosol particles.

The health effects of aerosol particles depend on the size and chemical composition of individual particles rather than the overall mixed composition. Most methods now used for analysis of particulate matter give information only on the average elemental composition. The development of a single-particle chemical analyzer could provide a breakthrough in aerosol analysis and perhaps find important applications in air pollution, public health, and atmospheric science.



Schematic of the particle analysis by mass spectrometry system.